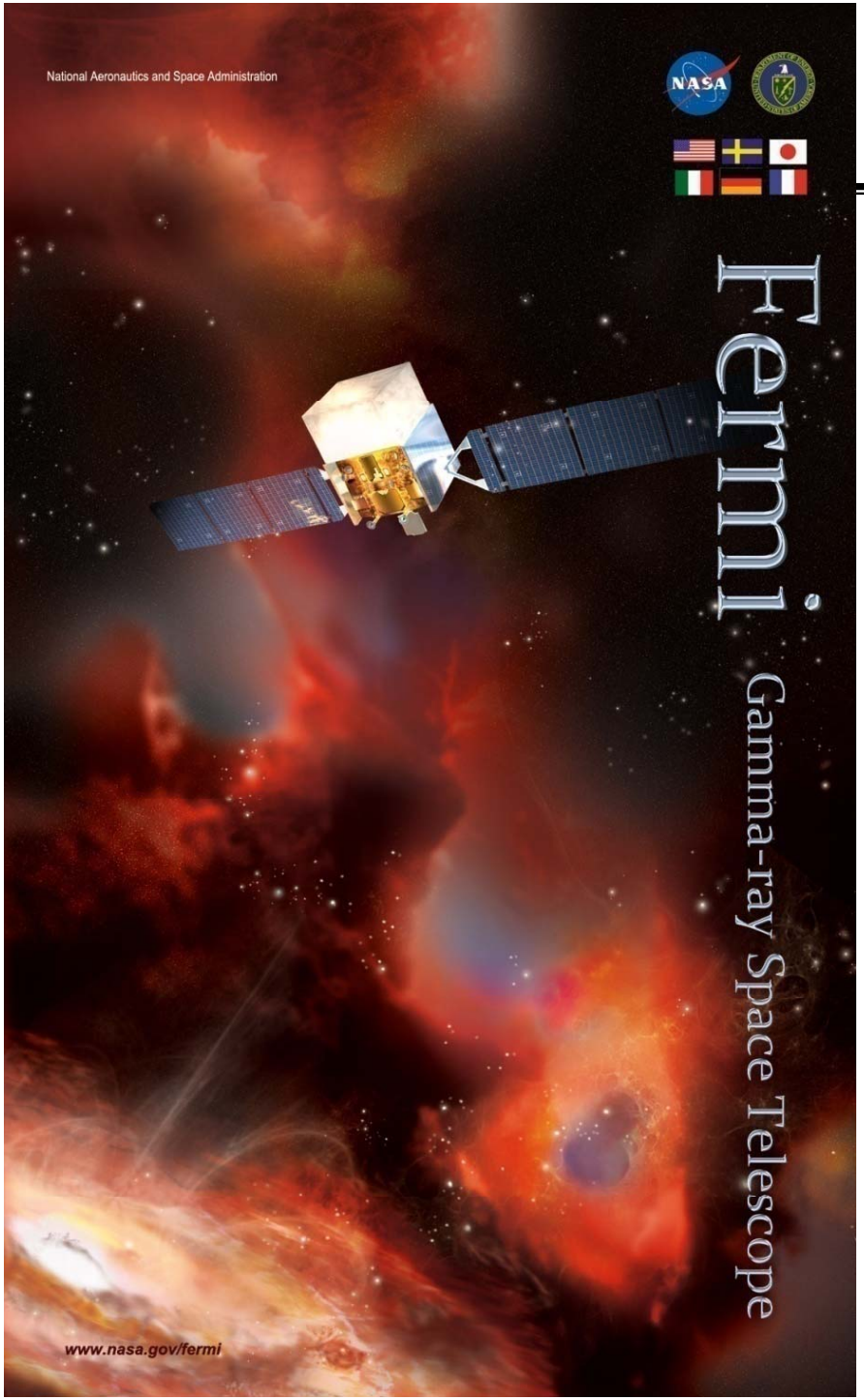

Fermi GBM:
Results from the First Year +

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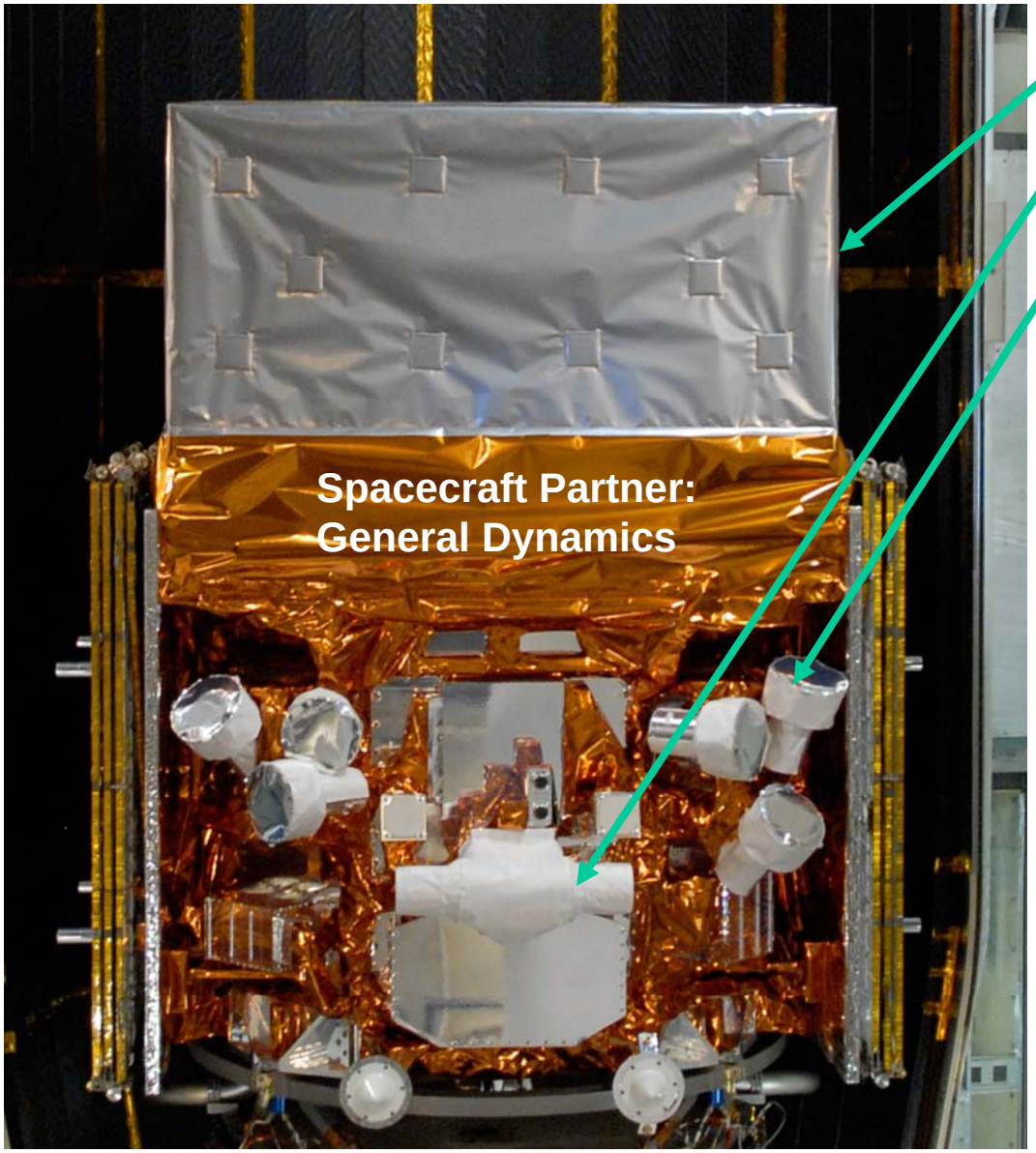
NASA UAHuntsville THE UNIVERSITY OF ALABAMA IN HUNTSVILLE MPE Los Alamos NATIONAL LABORATORY

The Fermi Observatory



Large AreaTelescope (LAT)
20 MeV - >300 GeV

Gamma-ray Burst Monitor (GBM)
NaI and BGO Detectors
8 keV - 40 MeV

KEY FEATURES

- **Huge field of view**
  - **–LAT: 20% of the sky at any instant; in sky survey mode, expose all parts of sky for ~30 minutes every 3 hours. GBM: whole unocculted sky at any time.**
- **Huge energy range, including largely unexplored band 10 GeV - 100 GeV. Total of >7 energy decades!**
- **Large leap in all key capabilities. Great discovery potential.**

GBM Science

Techniques

- Short transients detected by on-board trigger algorithm
  - trigger timescales 16 ms – 16 s (currently longest is 8 s)
- Pulsed sources detected by power spectral analysis and/or epoch folding
- Longer-term transients and persistent sources detected by Earth occultation

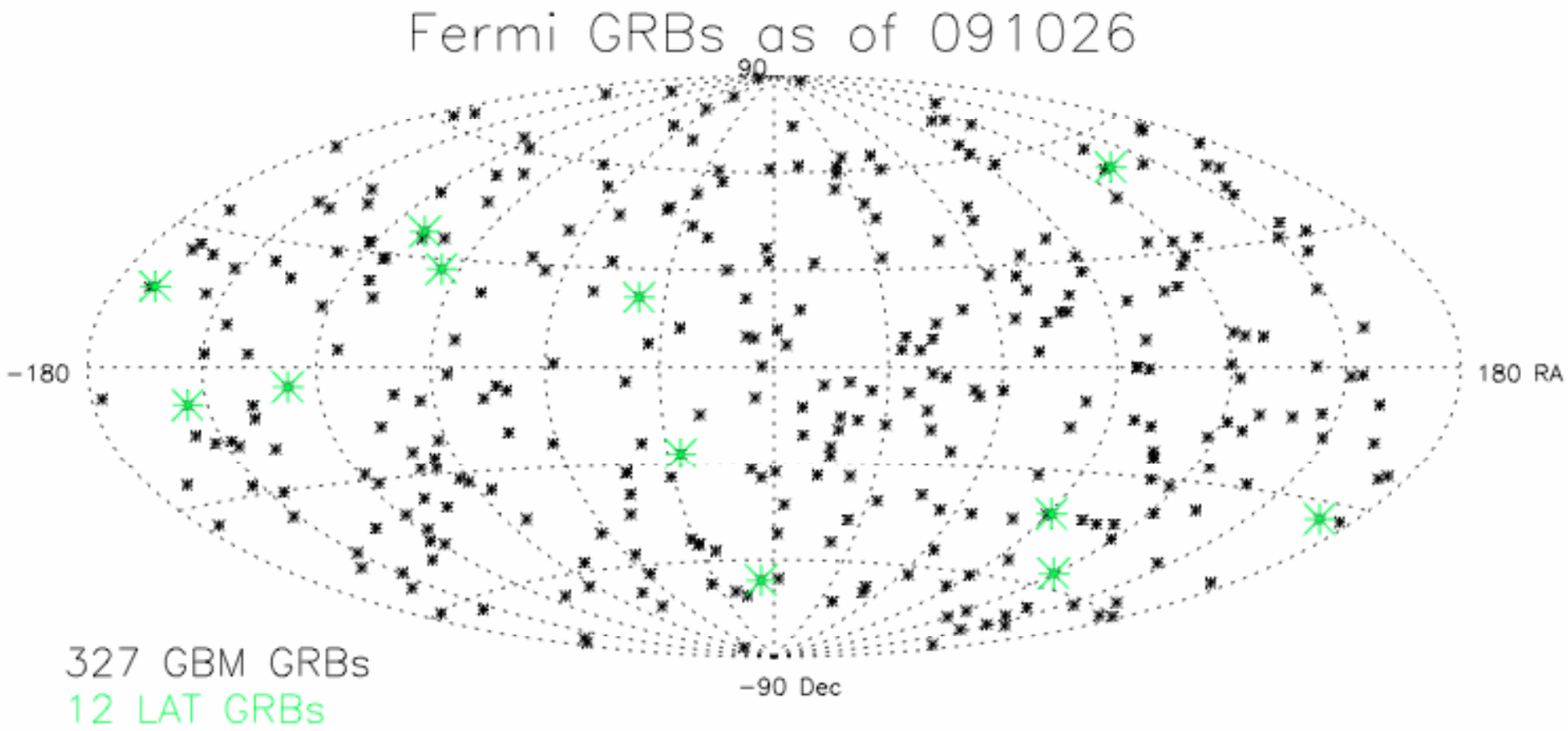
Triggered Sources

- Gamma-ray bursts (GRBs) – 353
- Soft Gamma Repeaters (SGRs) – 168
- Terrestrial Gamma Flashes (TGFs) – 18
- Solar flares - 1

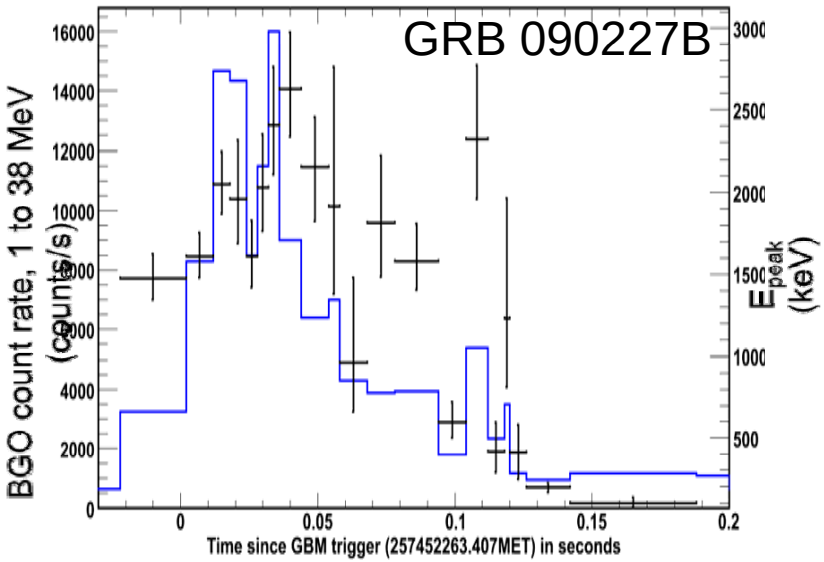
Non-triggered Sources

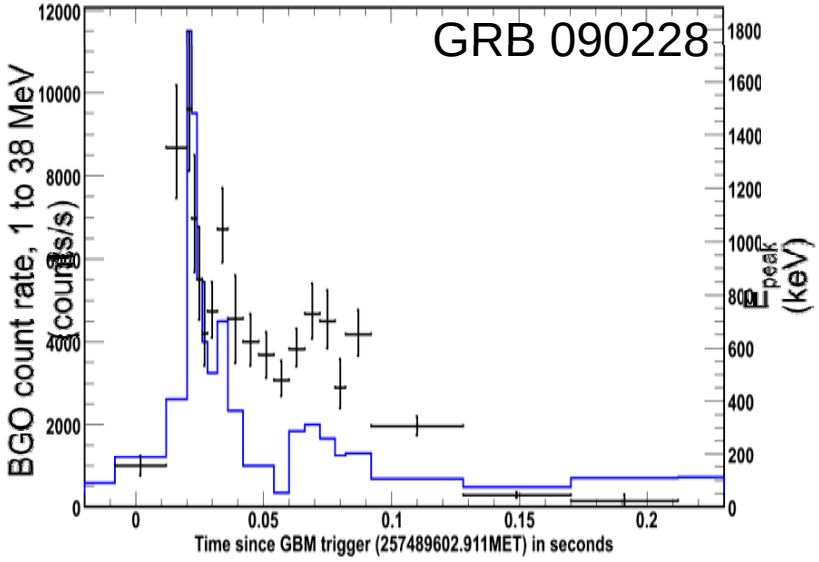
- X-ray binaries: HMXBs, LMXBs, Be binaries, microquasars
- AGNs

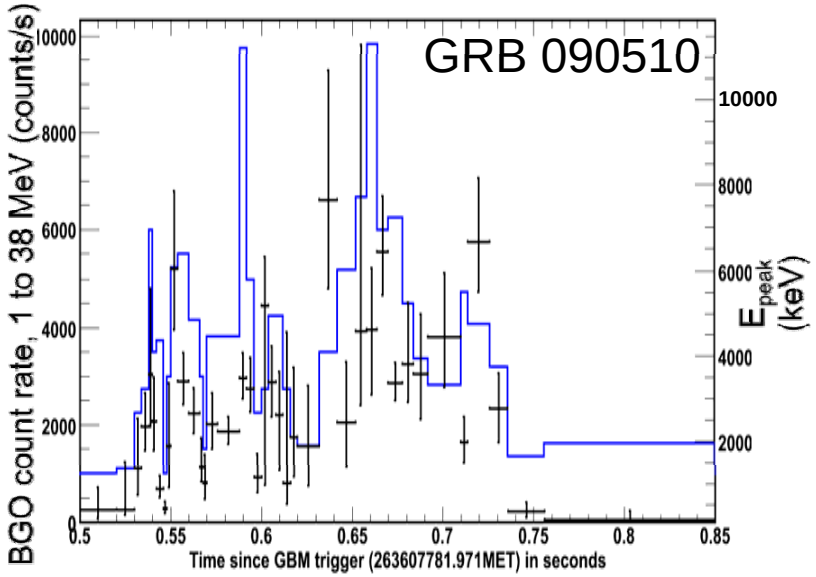
Gamma Ray Bursts



Fine Time-Resolved Spectroscopy of Short GRBs

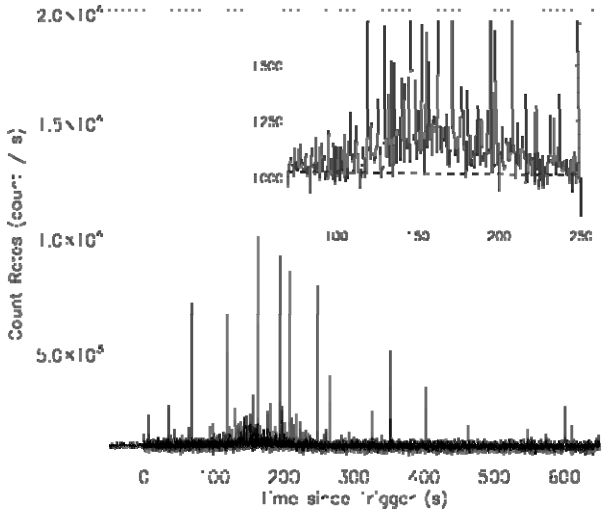


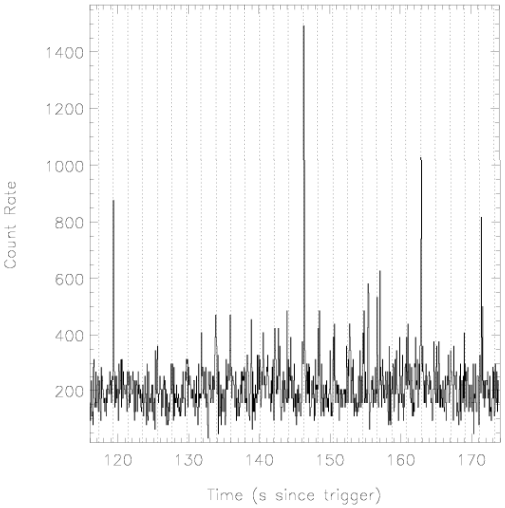




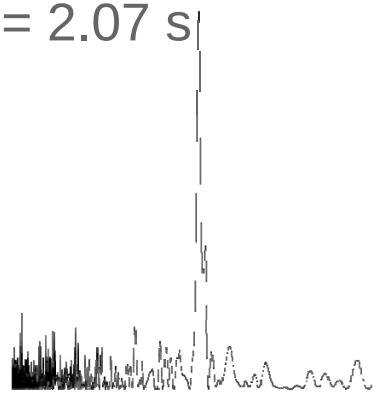
- Similar to long GRBs (Ford et al.), but
  - Contracted in time
  - Shifted to higher energies
- Epeak tracks lightcurves like long GRBs
- Hardest park is not always at the beginning
- Most intense peaks are not always hardest

Fermi / GBM Detection of Pulsed Hard X-ray Emission from SGR 1550-5418



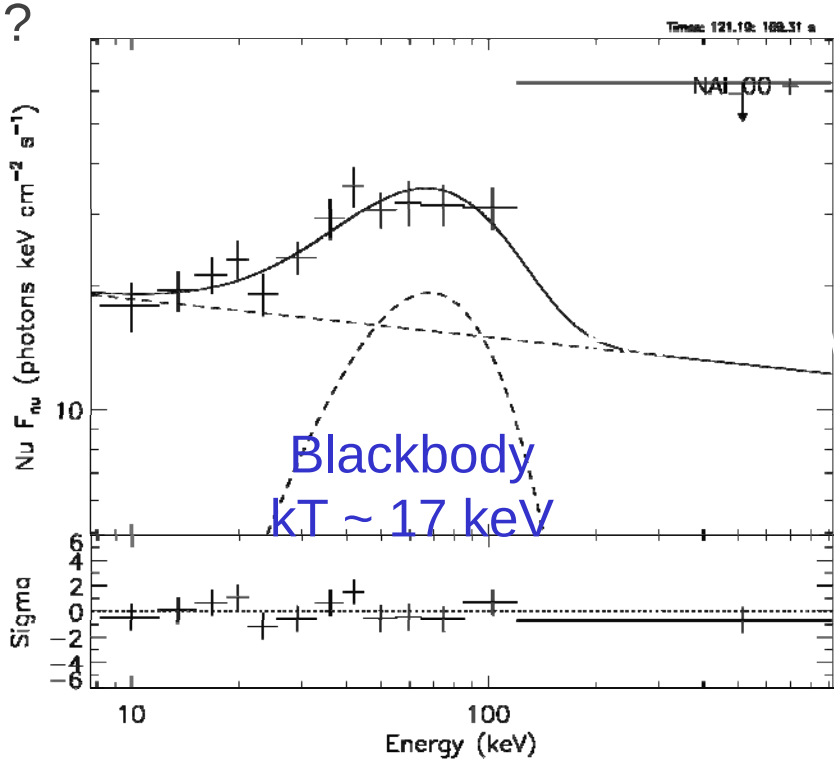


P = 2.07 s

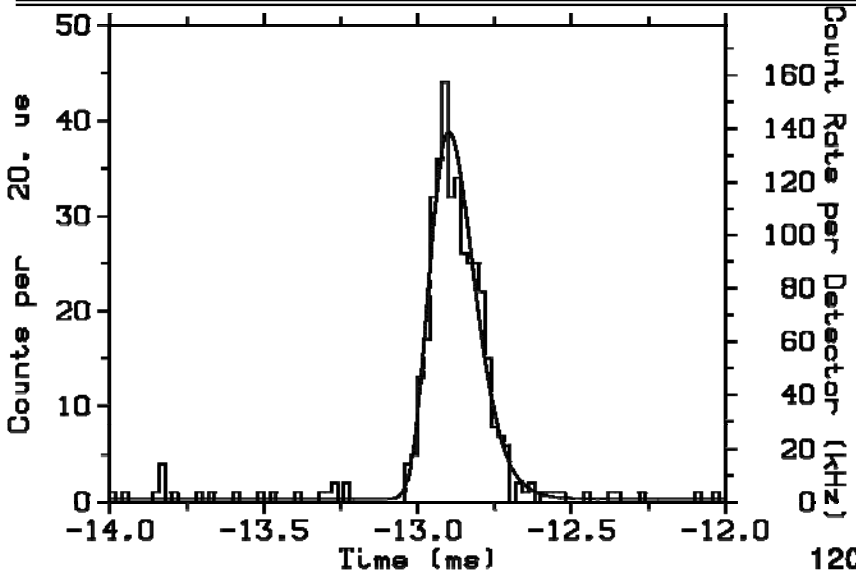


(Kaneko et al. 2009, ApJ submitted)

- Pulsation at spin period (50-100 keV)
- Thermal component → R ~ 120 m size of "trapped fireball" in twisted B?

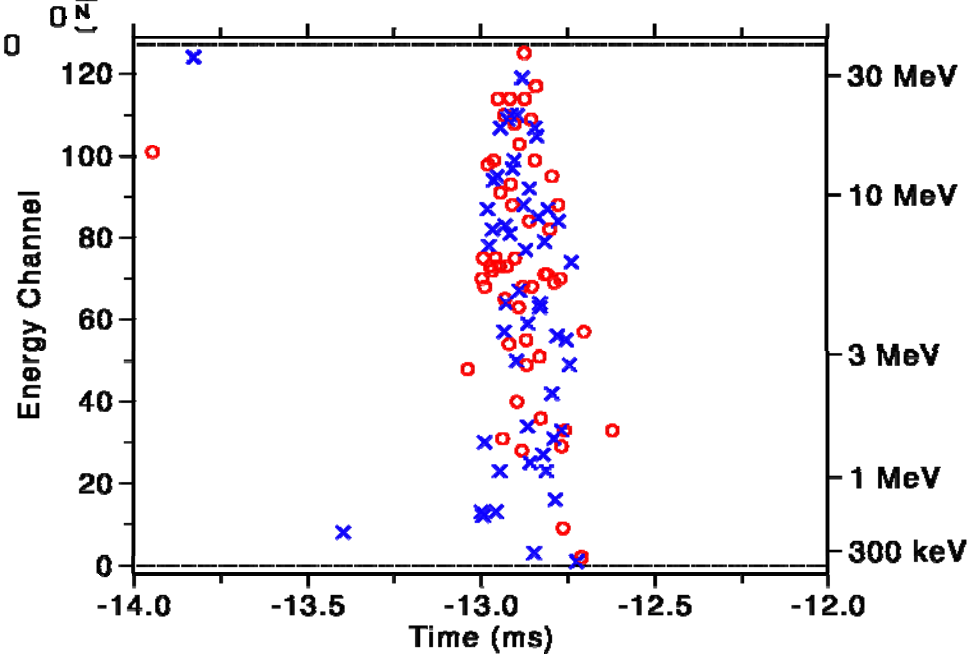


Terrestrial Gamma Flashes (TGF)



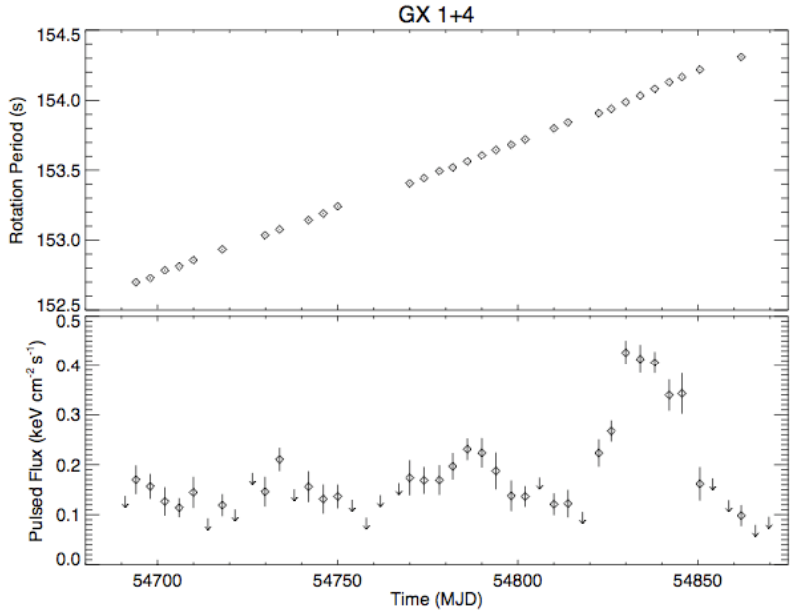
t_{90} = 0.22 ms

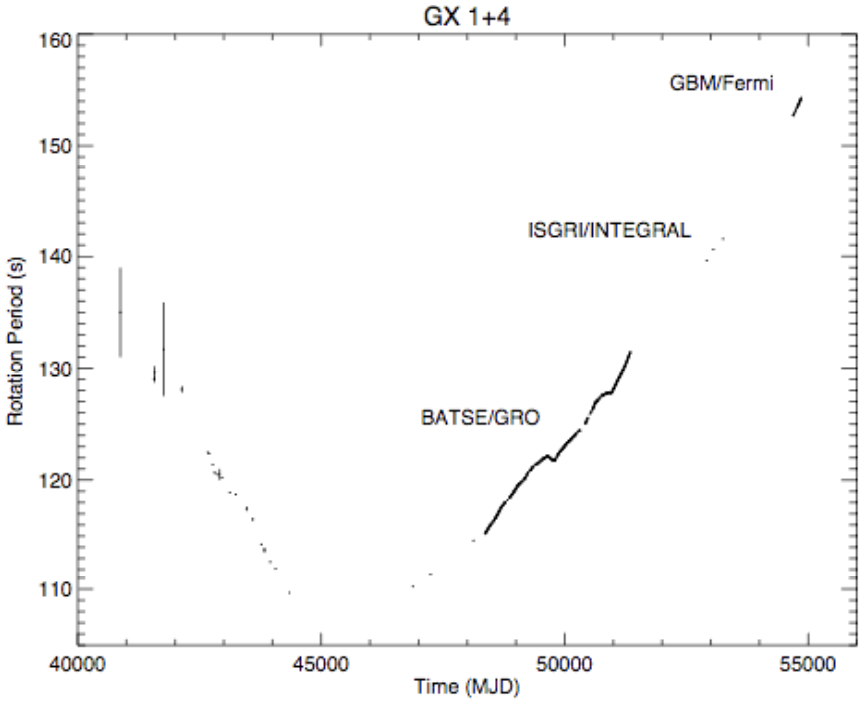
- BGO detectors and TTE excellent
- 18 TGF triggers to date
- Shorter than GRBs
- Higher average photon energy
- Much higher count rates
- New TGF specific triggers!



GBM Pulsar Analysis

- **Search for pulsars from 1 mHz -- 2 Hz in CTIME data.**
- **Several seen routinely: 4U 1626-67, Cen X-3, OAO 1657-415, GX 1+4, Vela X-2, GX 301-2.**
- **Several seen only in parts of orbit: Her X-1.**
- **Several seen in outburst: EXO 2030+375, A 0535+6, A 1118-615.**
- **Sensitivity ~5 mCrab in 3 days**

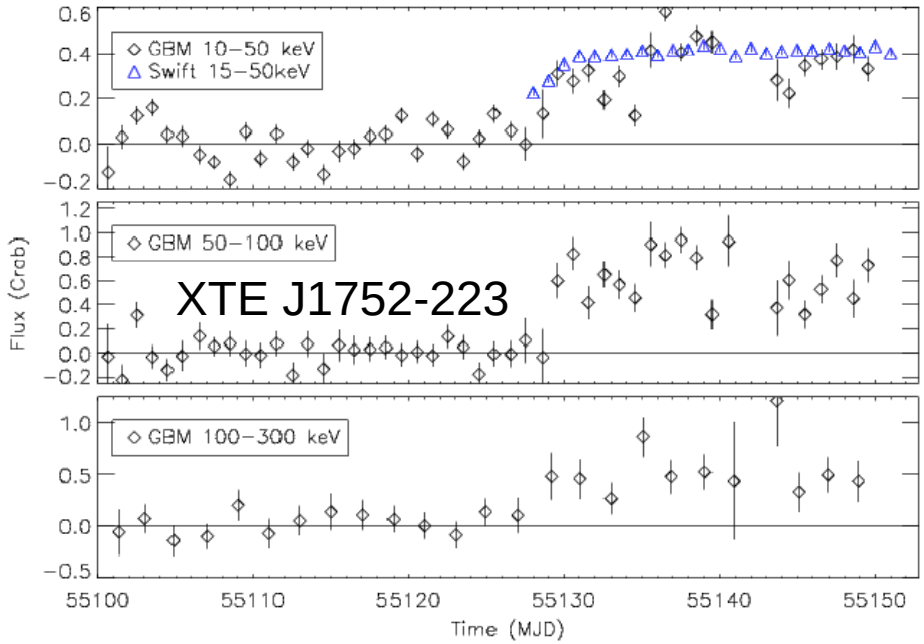


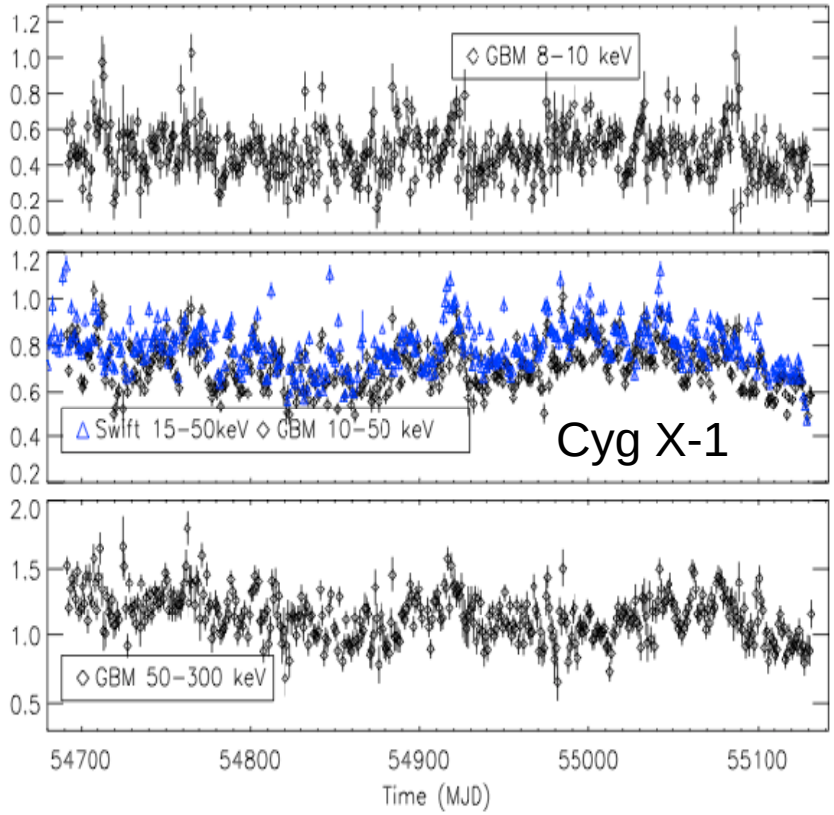


http://gammaray.nsstc.nasa.gov/gbm/science/pulsar/

GBM Earth Occultation Monitoring

- Catalog of 60 sources
  - X-ray binaries, Crab, Cen A
- 7 sources detected above 100 keV
- Complements Swift/BAT





http://gammaray.nsstc.nasa.gov/gbm/science/occultation/

Summary

- GBM has performed well in the first year+
- GBM triggers
  - 353 GRBs
  - 168 SGR events
  - 18 TGFs
  - 1 solar flare to date.
- Short GRBs appear contracted in time and shifted to higher energy than long GRBs.
- Pulsed persistent emission from SGR 1550-5418 detected
- TGFs are shorter, have higher average photon energies, and much higher count rates than GRBs
- GBM monitoring of accreting pulsars provides long-term spin-histories.
- GBM Earth occultation monitoring complements Swift

GBM Detectors

- **Placement of detectors to view entire sky while maximizing sensitivity to events seen in common with the LAT.**
- **4 x 3 NaI Detectors with different orientations.**
- **2 x 1 BGO Detector either side of spacecraft.**

The Large Area Telescope (LAT)

GBM BGO detector.
200 keV -- 40 MeV
126 cm^2, 12.7 cm
Spectroscopy
Bridges gap between NaI and LAT.

GBM NaI detector.
8 keV -- 1000 keV
126 cm^2, 1.27 cm
Triggering, localization, spectroscopy.